make it to the big leagues, but that wasn't the point. The odds were against him, just as they were against any high school player. The scouts adored high school players, and they especially adored high school pitchers. High school pitchers were so far away from being who they would be when they grew up that you could imagine them becoming almost anything. High school pitchers also had brand-new arms, and brand-new arms were able to generate the one asset scouts could measure: a fastball's velocity. The most important quality in a pitcher was not his brute strength but his ability to deceive, and deception took many forms.

In any case, you had only to study the history of the draft to see that high school pitchers were twice less likely than college pitchers, and four times less likely than college position players, to make it to the big leagues. Taking a high school pitcher in the first round—and spending 1.2 million bucks to sign him—was exactly the sort of thing that happened when you let scouts have their way. It defied the odds; it defied reason. Reason, even science, was what Billy Beane was intent on bringing to baseball. He used many unreasonable means—anger, passion, even physical intimidation—to do it. "My deep-down belief about how to build a baseball team is at odds with my day-to-day personality," he said. "It's a constant struggle for me."

It was hard to know what Grady Fuson imagined would happen after he took a high school pitcher with the first pick. On draft day the Oakland draft room was a ceremonial place. Wives, owners, friends of the owners—all these people who made you think twice before saying [redacted]—gathered politely along the back wall of the room to watch the Oakland team determine its future. Grady, a soft five foot eight next to Billy's still dangerous-looking six foot four, might have thought that their presence would buffer Billy's fury. It didn't. Professional baseball had violently detached Billy Beane from his youthful self, but Billy was still the guy whose anger after striking out caused the rest of the team to gather on the other end of the bench. When Grady leaned into the phone to take

Bonderman, Billy, in a single motion, erupted from his ch grabbed it, and hurled it right through the wall. When the chai the wall it didn't bang and clang; it exploded. Until they saw hole Billy had made in it, the scouts had assumed that the was, like their futures, solid.

Up till then, Grady had every reason to feel secure in his Other teams, when they sought to explain to themselves why Oakland A's had won so many games with so little money, excuse themselves for winning so few with so much, usu invoked the A's scouting. Certainly, Grady could never have in ined that his scouting department was on the brink of total o haul, and that his job was on the line. But that was the direc Billy's mind was heading. He couldn't help but notice that scouting department was the one part of his organization most resembled the rest of baseball. From that it followed th was most in need of change. "The draft has never been anyth but a[redacted]g crapshoot," Billy had taken to saying, "We take guys and we celebrate if two of them make it. In what other b ness is two for fifty a success? If you did that in the stock mar you'd go broke." Grady had no way of knowing how much I disapproved of Grady's most deeply ingrained attitudes—that I had come to believe that baseball scouting was at roughly same stage of development in the twenty-first century as pr sional medicine had been in the eighteenth. Or that all of Bi beliefs, at the moment of Jeremy Bonderman's selection, acqu a new intensity.

On the other hand, Grady wasn't entirely oblivious to Bi hostility. He had known enough to be uncomfortable the v before the draft, when Billy's assistant, Paul DePodesta, turned up in the draft room with his laptop. Paul hadn't playe ball. Paul was a Harvard graduate. Paul looked and sounded r like a Harvard graduate than a baseball man. Maybe more to point, Paul shouldn't have even been in the draft room. The room was for scouts, not assistant general managers.

hopes and dreams. He had reason to feel some distaste for baseball's mystical nature. He would soon be handed a weapon to destroy it.

SANDY ALDERSON has a clear memory from earlier that spring of 1990, of Billy Beane taking batting practice. He didn't know much about Billy and wondered what kind of player he was. "He was very undisciplined at the plate," Alderson said. "Not a lot of power. I remember after I watched him very specifically asking: why is this guy even on the team?" Not that it mattered. Tony La Russa was the A's manager and, in the great tradition of big-shot baseball managers, he paid only faint attention to what the GM had to say.

That was one of the many things about baseball Alderson was determined to change. When Billy came to work inside the A's front office in 1993, he walked into the early stages of a fitful science experiment. When Alderson had been hired as the A's general manager a decade earlier, he'd been a complete outsider to baseball. This was rare. Most GMs start out as scouts and rise up through the baseball establishment. Alderson was an expensively educated San Francisco lawyer (Dartmouth College, Harvard Law School) with no experience of the game, outside of a bit of time on school playing fields. He was also a former Marine Corps officer, and his self-presentation was much closer to "former Marine Corps officer" than "fancy-pants lawyer." "Sandy didn't know [redacted] about baseball," says Harvey Dorfman, the baseball psychologist Alderson more or less invented. "He was a neophyte. But he was a progressive thinker. And he wanted to understand how the game worked. He also had the capacity to instill fear in others."

When Alderson entered the game he wanted to get his mind around it, and he did. He concluded that everything from on-field strategies to player evaluation was better conducted by scientific investigation—hypotheses tested by analysis of historical statistical baseball data—than by reference to the collective wisdom of old baseball men. By analyzing baseball statistics you could see through a lot of baseball nonsense. For instance, when baseball managers talked about scoring runs, they tended to focus on team batting average, but if you ran the analysis you could see that the number of runs a team scored bore little relation to that team's batting average. It correlated much more exactly with a team's on-base and slugging percentages. A lot of the offensive tactics that made baseball managers famous—the bunt, the steal, the hit and run—could be proven to have been, in most situations, either pointless or self-defeating. "I figured out that managers do all this [redacted] because it is safe," said Alderson. "They don't get criticized for it." He wasn't particularly facile with numbers, but he could understand them well enough to use their conclusions. "I couldn't do a regressions analysis," he said, "but I knew what one was. And the results of them made sense to me."

Alderson hadn't set out to reexamine the premises of professional baseball but he wound up doing it anyway. For a long stretch, his investigations were largely academic. "You have to remember," he said, "that there wasn't any evidence that any of this [redacted] worked. And I had credibility problems. I didn't have a baseball background." The high payroll Oakland teams managed by Tony La Russa had done well enough in the late 1980s and early 1990s that Alderson felt he should "defer to success." For more than a decade he could afford to do this. Since the late 1970s the A's had been owned by Walter A. Haas, Jr., who was, by instinct, more of a philanthropist than a businessman. Haas viewed professional baseball ownership as a kind of public trust and spent money on it accordingly. In 1991, the Oakland A's actually had the highest payroll in all of baseball. Haas was willing to lose millions to field a competitive team that would do Oakland proud, and he did. The A's had gone to the World Series three straight seasons from 1988 to 1990.

Deferring to success became an untenable strategy in 1995,

other hand, for a flake to hit 48 homers. Hitting 48 homers is something done by large, slow men three-quarters thespian. . . .

Start here

James was an aesthete. But he was also a pragmatist: he had happened upon something broken and wanted to fix it. But he could only fix what he had the tools to fix. The power of statistical analysis depends on sample size: the larger the pile of data the analyst has to work with, the more confidently he can draw specific conclusions about it. A right-handed hitter who has gone two for ten against left-handed pitching cannot as reliably be predicted to hit .200 against lefties as a hitter who has gone 200 for 1,000. The offensive statistics available to James in 1978 were sufficiently comprehensive to reach specific, meaningful conclusions. Offense he could fix. He couldn't fix fielding because, as he had explained in his first *Abstract*, there wasn't the data available to make a meaningful appraisal of fielding. Pitching didn't need to be fixed. Or, at any rate, James didn't think it did.

In 1979, in the third, now annual, *Baseball Abstract*, James wrote, "a hitter should be measured by his success in that which he is trying to do, and that which he is trying to do is create runs. It is startling, when you think about it, how much confusion there is about this. I find it remarkable that, in listing offenses, the league will list first—meaning best—not the team which scored the most runs, but the team with the highest batting average. It should be obvious that the purpose of an offense is not to compile a high batting average." Because it was not obvious, at least to the people who ran baseball, James smelled a huge opportunity. How *did* runs score? "We can't directly see how many runs each player creates," he wrote, "but we can see how many runs each team creates."

He set out to build a model to predict how many runs a team would score, given its number of walks, hits, stolen bases, etc. He'd dig out the numbers for, say, the 1975 Red Sox. (Walks by

individual players were still hard to find in 1975, thanks to Henry Chadwick, but team totals were available.) He could also find out how many runs the 1975 Red Sox scored. What he needed to determine was the relative importance to the team's scoring of the various things Red Sox players did at the plate and on the base paths—that is, assign weights to outs, walks, steals, singles, doubles, etc. There was nothing elegant or principled in the way he went about solving the problem. He simply tried out various equations on the right side of the equals sign until he found one that gave him the team run totals on the left side. The first version of what James called his "Runs Created" formula looked like this:

$$\text{Runs Created} = (\text{Hits} + \text{Walks}) \times \text{Total Bases}/(\text{At Bats} + \text{Walks})$$

Crude as it was, the equation could fairly be described as a scientific hypothesis: a model that would predict the number of runs a team would score given its walks, steals, singles, doubles, etc. You could plug actual numbers from past seasons into the right side and see if they gave you the runs the team scored that season. James was, in a sense, trying to predict the past. If the actual number of runs scored by the 1975 Boston Red Sox differed dramatically from the predicted number, his model was clearly false. If they were identical, James was probably onto something. As it turned out, James was onto something. His model came far closer, year in and year out, to describing the run totals of every big league baseball team than anything the teams themselves had come up with.

That, in turn, implied that professional baseball people had a false view of their offenses. It implied, specifically, that they didn't place enough value on walks and extra base hits, which featured prominently in the "Runs Created" model, and placed too much value on batting average and stolen bases, which James didn't even bother to include. It implied that sacrifices of any sort were aptly

named, as they made no contribution whatsoever. That is: outs were more precious than baseball people believed, or seemed to believe. Not all baseball people, of course. The Jamesean analysis was consistent with an approach to the game championed most vocally by the former manager of the Baltimore Orioles, Earl Weaver. Weaver designed his offenses to maximize the chances of a three-run homer. He didn't bunt, and he had a special taste for guys who got on base and guys who hit home runs. Big ball, as opposed to small ball.

But once again, the details of James's equation didn't matter all that much. He was creating opportunities for scientists as much as doing science himself. Other, more technically adroit people would soon generate closer approximations of reality. What mattered was (a) it was a rational, testable hypothesis; and (b) James made it so clear and interesting that it provoked a lot of intelligent people to join the conversation. "The fact that the formulas work with the accuracy that they do is a way of saying there are essentially stable relationships between batting average, home runs, walks, other offensive elements—and runs," wrote James.

Stop

This kind of talk was catnip to people whose lives were devoted to discovering stable relationships in a seemingly unstable world: physicists, biologists, economists. There was a young statistician at the RAND Corporation, a future chair of the Harvard statistics department, named Carl Morris. "I'd been thinking about advanced ideas in baseball analysis," said Morris, "and was impressed that someone else was, too, who wrote about it in a very interesting way." Morris counted the days until the next *Baseball Abstract* appeared. James pointed the way to big questions that Morris could address more rigorously than even James could.

There was also a bright young government economist with the Office of Management and Budget named Eddie Epstein. He stumbled across the *Abstract* and decided he was in the wrong line of work. "I read the *Abstract*," he said, "and the light bulb went off:

I can do this! The way Bill laid out very clearly what could be gleaned from these mountains of baseball data. In the past an awful lot was thought to be unknowable." Epstein began to pester Edward Bennett Williams, the owner of the Baltimore Orioles, for a job.

Then there were the few hobbyists who had been active before James began writing his *Abstracts*. Dick Cramer was a research scientist for the pharmaceutical company then called SmithKline French (now GlaxoSmithKline), and so had access to a computer. By day he used the SmithKline computers to discover new drugs and by night he used them to test his own theories about baseball. For instance, Cramer had a hypothesis about clutch hitting: it didn't exist. No matter what the announcers said, and what the coaches believed, major league baseball players did not perform particularly well—or particularly badly—in critical situations. On the one hand, it made a funny kind of sense: no one who behaved differently under pressure would ever make it to the big leagues. On the other hand, it contradicted the sacred, received wisdom in baseball. The sheer counterintuitiveness of his notion delighted Cramer. "It violates everyone's personal experience of pressure, and how they cope with it," he said. And yet it was true, or impossible to disprove. Cramer had tested it and found no evidence that players hit differently in one situation than any other—with a pair of exceptions. Some left-handed hitters fared worse against lefties than righties, and some right-handed hitters fared worse against righties than lefties.

Cramer's work has subsequently withstood intense, repeated critical scrutiny, but until Bill James came along no one paid it any attention. "Until Bill came along," Cramer says, "it was just three or four of us writing letters to each other. Even my own family would say, 'This is a crazy way to spend your time.'"

Cramer, like James, understood that the search for baseball knowledge was constrained by the raw statistics, and began to think seriously about starting a company to collect better data

round draft pick, along with a first-round compensation pick. The former they'd used to draft Benjamin Fritz, a pitcher they judged to have a brighter and cheaper future than Isringhausen; the latter, to acquire Jeremy Brown.

The Blue Ribbon Commission had asked the wrong question. The question wasn't whether a baseball team could keep its stars even after they had finished with their six years of indentured servitude and became free agents. The question was: how did a baseball team find stars in the first place, and could it find new ones to replace the old ones it lost? How fungible were baseball players? The short answer was: a lot more fungible than the people who ran baseball teams believed.

Finding pitchers who could become successful closers wasn't all that difficult. To fill the hole at the back of his bullpen Billy had traded to the Toronto Blue Jays a minor league third baseman, Eric Hinske, for Billy Koch, another crude fireballer. He knew that Hinske was very good—he'd wind up being voted 2002 Rookie of the Year in the American League—but the Oakland A's already had an even better third baseman, Eric Chavez. Plus, Billy knew that, barring some disaster, Koch, too, would gain a lot of value as an asset. Koch would get his saves and be perceived by other teams to be a much more critical piece of a successful team than he actually was, whereupon the A's would trade him for something cheaper, younger, and possibly even better.

The loss of Johnny Damon, the A's former center fielder, presented a different sort of problem. When Damon signed with Boston, the A's took the Red Sox's first-round pick (to select Nick Swisher) plus a compensation pick. But Damon left two glaring holes: on defense in center field, on offense in the leadoff spot. Of the two the offense was the easiest to understand, and dismiss. When fans watched Damon, they saw the sort of thrilling leadoff hitter that a team simply had to have if it wanted to be competitive. When the A's front office watched Damon, they saw something else: an imperfect understanding of where runs come from.

Paul DePodesta had been hired by Billy Beane before the 1999 season, but well before that he had studied the question of why teams win. Not long after he'd graduated from Harvard, in the mid-nineties, he'd plugged the statistics of every baseball team from the twentieth century into an equation and tested which of them correlated most closely with winning percentage. He'd found only two, both offensive statistics, inextricably linked to baseball success: on-base percentage and slugging percentage. Everything else was far less important.

Not long after he arrived in Oakland, Paul asked himself a question: what was the relative importance of on-base and slugging percentage? His answer began with a thought experiment: if a team had an on-base percentage of 1.000 (referred to as "a thousand")—that is, every hitter got on base—how many runs would it score?* An infinite number of runs, since the team would never make an out. If a team had a slugging percentage of 1.000—meaning, it gained a base for each hitter that came to the plate—how many runs would it score? That depended on how it was achieved, but it would typically be a lot less than an infinite number. A team might send four hitters to the plate in an inning, for instance. The first man hits a home run, the next three make outs. Four plate appearances have produced four total bases and thus a slugging percentage of 1.000 and yet have scored only one run in the inning.

* These "percentages" are designed to drive anyone who thinks twice about them mad. It's one thing to give 110 percent for the team, but it is another to get on base 1,000 percent of the time. On-base "percentage" is actually on-base "per thousand." A batter who gets on base four out of ten times has an on-base "percentage" of four hundred (.400). Slugging "percentage" is even more mind-bending as it is actually "per four thousand." A perfect slugging "percentage"—achieved by hitting a home run every time—is four thousand: four bases for every plate appearance. But for practical purposes, on-base and slugging are assumed to be measured on identical scales. At any rate, the majority of big league players have on-base percentages between three hundred (.300) and four hundred (.400) and slugging percentages between three hundred and fifty (.350) and five hundred and fifty (.550).

Baseball fans and announcers were just then getting around to the Jamesean obsession with on-base and slugging percentages. The game, slowly, was turning its attention to the new statistic, OPS (on base plus slugging). OPS was the simple addition of on-base and slugging percentages. Crude as it was, it was a much better indicator than any other offensive statistic of the number of runs a team would score. Simply adding the two statistics together, however, implied they were of equal importance. If the goal was to raise a team's OPS, an extra percentage point of on-base was as good as an extra percentage point of slugging.

Before his thought experiment Paul had felt uneasy with this crude assumption; now he saw that the assumption was absurd. An extra point of on-base percentage was clearly more valuable than an extra point of slugging percentage—but by how much? He proceeded to tinker with his own version of Bill James's "Runs Created" formula. When he was finished, he had a model for predicting run production that was more accurate than any he knew of. In his model an extra point of on-base percentage was worth three times an extra point of slugging percentage.

Paul's argument was radical even by sabermetric standards. Bill James and others had stressed the importance of on-base percentage, but even they didn't think it was worth three times as much as slugging. Most offensive models assumed that an extra point of on-base percentage was worth, at most, one and a half times an extra point of slugging percentage. In major league baseball itself, where on-base percentage was not nearly so highly valued as it was by sabermetricians, Paul's argument was practically heresy.

Paul walked across the hall from his office and laid out his argument to Billy Beane, who thought it was the best argument he had heard in a long time. Heresy was good: heresy meant opportunity. A player's ability to get on base—especially when he got on base in unspectacular ways—tended to be dramatically underpriced in relation to other abilities. Never mind fielding skills and foot speed. The ability to get on base—to avoid making outs—was

underpriced compared to the ability to hit with power. The one attribute most critical to the success of a baseball team was an attribute they could afford to buy. At that moment, what had been a far more than ordinary interest in a player's ability to get on base became, for the Oakland A's front office, an obsession.

To most of baseball Johnny Damon, on offense, was an extraordinarily valuable leadoff hitter with a gift for stealing bases. To Billy Beane and Paul DePodesta, Damon was a delightful human being, a pleasure to have around, but an easily replaceable offensive player. His on-base percentage in 2001 had been .324, or roughly 10 points below the league average. True, he stole some bases, but stealing bases involved taking a risk the Oakland front office did not trust even Johnny Damon to take. The math of the matter changed with the situation, but, broadly speaking, an attempted steal had to succeed about 70 percent of the time before it contributed positively to run totals.

The offense Damon had provided the 2001 Oakland A's was fairly easy to replace; Damon's defense was not. The question was how to measure what the Oakland A's lost when Terrence Long and not Johnny Damon, played center field. The short answer was that they couldn't, not precisely. But they could get closer than most to an accurate answer—or thought that they could. Something had happened since Bill James first complained about the meaninglessness of fielding statistics. That something was new information, and a new way of thinking about an old problem. Oddly, the impulse to do this thinking had arisen on Wall Street.

IN THE EARLY 1980S, the U.S. financial markets underwent an astonishing transformation. A combination of computing power and intellectual progress led to the creation of whole new markets in financial futures and options. Options and futures were really just fragments of stocks and bonds, but the fragments soon became so arcane and inexplicable that Wall Street created a sin

against the Minnesota Twins, had two horrendous outings. No one could have predicted that.

The postseason partially explained why baseball was so uniquely resistant to the fruits of scientific research: to *any* purely rational idea about how to run a baseball team. It wasn't just that the game was run by old baseball men who insisted on doing things as they had always been done. It was that the season ended in a giant crapshoot. The play-offs frustrate rational management because, unlike the long regular season, they suffer from the sample size problem. Pete Palmer, the sabermetrician and author of *The Hidden Game of Baseball*, once calculated that the average difference in baseball due to skill is about one run a game, while the average difference due to luck is about four runs a game. Over a long season the luck evens out, and the skill shines through. But in a series of three out of five, or even four out of seven, anything can happen. In a five-game series, the worst team in baseball will beat the best about 15 percent of the time; the Devil Rays have a prayer against the Yankees. Baseball science may still give a team a slight edge, but that edge is overwhelmed by chance. The baseball season is structured to mock reason.

Because science doesn't work in the games that matter most, the people who play them are given one more excuse to revert to barbarism. The game is structured, psychologically (though not financially), as a winner-take-all affair. There isn't much place for the notion that a team that falls short of the World Series has had a great season. At the end of what was now widely viewed as a failed season, all Paul DePodesta could say was, "I hope they continue to believe that our way doesn't work. It buys us a few more years."

BILLY BEANE had been surprisingly calm throughout his team's play-off debacle. Before the second game against the Twins, when I'd asked him why he seemed so detached—why he wasn't walking around the parking lot with his white box—he said, "My [redacted] doesn't work in the play-offs. My job is to get us to the play-offs. What happens after that is [redacted]." It was Paul who took a bat to the chair in the video room, late at night after the fifth game, after everyone else had gone home for good. Billy's attitude seemed to be, all that management can produce is a team good enough to triumph in a long season. There are no secret recipes for the postseason, except maybe having three great starting pitchers, and he had that.

His objective spirit survived his team's defeat a week. The fact that his team had lost to the clearly inferior Minnesota Twins festered. He never said it, but it was nonetheless evident that he couldn't quite believe how little appreciation there was for what he'd done. Even his owner, who was getting multiples more for his money than any owner in baseball, complained. The public reaction to the thing ate at Billy. In these situations, when his mind was disturbed, he often went looking to make a trade. But there was no player on whom his mind naturally fixed; the only person in the organization whose riddance would make him happier was his manager, Art Howe. It wasn't long before he had a novel idea: trade Art.

It took him about a week to do it. He called New York Mets GM Steve Phillips and told him that Art was a superb manager but his latest one-year contract called for a big raise, and Oakland couldn't really afford to pay it. Phillips had just fired his own manager, Bobby Valentine, and was in a bit of a fix. Billy had thought he might even get a player from the Mets for Art but in the end settled on moving Art's salary. Art signed a five-year deal for $2 million a year to manage the New York Mets. In Art's place Billy installed Ken Macha, the A's bench coach.

That made him feel better for a bit. Then it didn't. He had the feeling he'd come to the end of some line. Here they had run this low-budget franchise as efficiently as a low-budget franchise could be run and no one had even noticed. No one cared if you found rad-